HAZARDOUS MATERIALS SHIPPING:
DOT TRAINING. PART 2

OUTLINE – PART 2

• Emergency Response Information
• Contamination Limits/Radiation Level Limits
• Placards
• Security and Safety Plans
• Incident Reporting
• Package Receipt
• Practical Application
• Conclusion
• Sample Questions

EMERGENCY RESPONSE INFORMATION
EMERGENCY RESPONSE INFORMATION (§172.600)

• Must:
  • Be printed legibly in English
  • Be immediately available/accessible for use at all times the hazardous material is present (away from the package containing the hazmat)
  • Include an emergency response phone number that is:
    • Monitored at all times and immediately connects a responder to a knowledgeable individual (or has immediate access to a knowledgeable individual)
    • Answering services, machines, etc., that require a call-back will not meet requirements
    • Printed prominently on the shipping paper

• May be on the shipping paper or in a supplemental document

Does not apply to hazardous materials excepted from shipping paper requirements

EMERGENCY RESPONSE INFORMATION (§172.600)

• Must include:
  • Basic description and technical name
  • Immediate hazards to health
  • Risk of fire or explosion
  • Immediate precautions in the event of accident or incident
  • Immediate methods for handling fires
  • Initial methods for handling spills or leaks in the absence of fire
  • Preliminary first aid measures

• May also refer to Emergency Response Guidebook, specific page (published by DOT)

CONTAMINATION LIMITS
RADIATION LEVEL LIMITS
NON-FIXED EXTERNAL RADIOACTIVE CONTAMINATION LIMITS (§173.443)

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Maximum permissible limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bq/cm²</td>
</tr>
<tr>
<td>Beta, gamma and low toxicity alphas</td>
<td>4</td>
</tr>
<tr>
<td>All other alphas</td>
<td>0.4</td>
</tr>
</tbody>
</table>

- Must be ALARA and meet maximum permissible limit
- Area wipe of 300 cm² using moderate pressure
- Measure activity on wipe using appropriate method

\[
\text{Activity} = \frac{\text{Radioactivity detected on wipe}}{\text{Surface area wiped} \times \text{detection efficiency} \times \text{wipe efficiency}}
\]

- Actual wipe efficiency may be used OR may assume to be 10%

NON-FIXED EXTERNAL RADIOACTIVE CONTAMINATION LIMITS (§173.443)

Example:
- I-131
- Area wiped = 300 cm²
- Assess wipes using pancake GM with an efficiency of 20%
  with NET result of 100 cpm
- Wipe efficiency of 10%
- Limit for I-131 = 240 dpm/cm²

\[
dpm = \frac{100 \text{ cpm}}{300 \text{ cm}^2 \times 0.2 \text{ cpm/dpm} \times 0.1} = 16.7 \text{ dpm/cm}^2
\]
RADIATION LEVEL LIMITS
(§173.441)

- Under normal shipping conditions:
  - Radiation levels at surface of package may not exceed 2 mSv/h (200 mrem/h)
  - TI may not exceed 10
  - Yellow III
- If radiation level limits are exceeded:
  - Package must be shipped EXCLUSIVE USE
  - Radiation levels at surface of package may not exceed 2 mSv/h (200 mrem/h)
  - TI must not exceed 10
  - Radiation levels on outside of vehicle may not exceed 2 mSv/h (200 mrem/h)
  - Radiation levels on outside of vehicle may not exceed 2 mSv/h (200 mrem/h)
- If EXCLUSIVE USE/CLOSED VEHICLE exceptions are used, offeror must provide specific written instructions for maintenance of exclusive use shipment controls
- Conveyance limits:
  - Sum of TIs ≤ 50 (except cargo aircraft/sea-going vessel)
  - No limit for EXCLUSIVE USE
  - No limit for shipments by aircraft (§§175.700 – 175.705; 176.700 – 176.720)
- Packages with surface radiation level > 2 mSv/h (200 mrem/h) or TIs > 10 may not be transported by aircraft

PLACARDS
(§172.504, 507, 516, 556)

- Required for:
  - Radioactive YELLOW-III
  - Unpackaged LSA-I or SCO-I
  - Exclusive Use shipment
  - Closed Vehicle shipments
  - HRCQ
- Must have Commercial Driver’s License (California requires Hazardous Materials Endorsement to CDL)
PLACARDS

• Placards must be:
  • Visible from each direction
  • Securely attached/affixed or in a holder
  • Located clear of any other items/devices
  • Located away from any marking that could reduce effectiveness
  • Have writing displayed horizontally reading left to right
  • Be maintained so format, legibility, color, visibility is not impaired
  • Affixed to a background of contrasting color or have an outer border which contrasts with background color
  • At least 250 mm (9.84") on each side, etc.

PLACARDS

($172.556$)

SAFETY AND SECURITY PLANS
SAFETY AND SECURITY PLANS (§172.800, 802)

• Each person that offers for transportation or transports HRCQ of radionuclides must develop and adhere to a transportation security plan.

• Plan must include:
  • Assessment of security risks
  • Personnel security – measures to confirm information provided by job applicants
  • Unauthorized access – measures to address risk that unauthorized persons may gain access to materials
  • En route security – measures to address security risks of shipments en route
  • Identification by job title of the senior management official responsible for development and implementation of plan
  • Security duties for each position or department including process of notifying employees when specific elements of plan have been implemented
  • Plan for training hazmat employees

• The Plan:
  • Must be in writing and retained as long as it remains in effect
  • Reviewed annually and revised and/or updated as necessary
  • Most recent version must be available to employees who implement it consistent with security clearance or background investigation restrictions and a demonstrated need to know
  • Re-training of all employees when security plan is updated or revised
  • Each person who must develop and implement the plan must maintain a copy of it that is accessible at or through the principal place of business and must make it available upon request to an authorized official of the DOT or DHS.

• A security plan used to satisfy requirements of 10CFR37 may be used to satisfy requirements if all items are addressed

INCIDENT REPORTING
INCIDENT REPORTING
§171.15, 171.16

- Immediate Notification (phone or on-line)
  - National Response Center
  - ASAP and ≤ 12 hours after event
  - Event occurs during transportation in commerce (including loading, unloading, temporary storage)
  - As a direct result of hazardous material:
    - Person is killed
    - Person receives injury requiring hospitalization
    - General public is evacuated for one hour or more
    - Major transportation artery or facility is closed or shut down for one hour or more
    - Operational flight pattern or routine of an aircraft is altered
  - Fire, breakage, spillage or suspected radioactive contamination occurs
  - Etc.
  - Infectious material, marine pollutant, event that seems like it should be reported (even if it doesn’t meet criteria), fire, etc., during aircraft transport of battery or battery-powered device

- Written Report
  - Use Hazardous Material Incident Report on DOT Form F 5800.1
  - Within 30 days
  - Any of the events requiring immediate notification
  - Any unintentional release of hazardous material
  - Specification cargo tank receives damage requiring repair
  - Undeclared hazmat is discovered
  - Fire, violent rupture, explosion, etc., that occurs as the result of a battery or battery-powered device (not only on aircraft)
  - Update to report must be made within one year if there is a death from injury caused by hazmat; misidentification of the hazmat or package info; damage, loss or related cost not known initially
  - Damage, loss, related cost changes by more than $25K or 10% of prior total estimate
  - Exception to reporting requirements for small quantities of materials, etc., but not for radioactive materials

PACKAGE RECEIPT
PACKAGE RECEIPT (10CFR20.1906)

- Not regulated by DOT; regulated by the NRC (10CFR20.1906)
- Contamination monitoring of the external surface of LABELED packages unless only gas or special form
- Must meet DOT contamination limits
- Radiation level monitoring of labeled packages unless ≤ Type A quantity
- Contamination and radiation level monitoring of all packages if evidence of degradation (crushed, wet, damaged)
- Performed ASAP and within 3 hrs after receipt (or 3 hrs of start of business if received after normal working hours)
- Notification of final carrier and NRC* if:
  - Removable surface contamination exceeds DOT contamination limits
  - External radiation levels exceed DOT radiation level limits (depend upon method of shipment; e.g., exclusive use)

*For agreement states, consult State regulations

LICENSEE must:

- Have written procedures for package opening
- Ensure procedures are followed
- Licensees transferring special form sources in licensee-owned/operated vehicles to and from a work site are exempt from contamination monitoring requirements but not from the radiation level monitoring required to ensure that source is still properly shielded
- Type B quantities
- Receive package when delivered or receive notification that package has arrived at carrier’s terminal and take possession expeditiously

PRACTICAL APPLICATION
PUTTING IT ALL TOGETHER...
ANALYSIS

- Quantity (Limited, Type A, etc.)
- Isotope
- Form (Special vs. Normal)
- Activity
- Package/Label
- Radiation Levels (T1 and Surface)
- Markings
- Package (Specification packaging)
- Radioactive
- Reportable Quantity
- Cargo Aircraft Only
- Weight, etc.
- Shipping Papers (Dangerous Goods Declaration)
- Contamination Limits
- Quality Control

EXAMPLE 1: ISOTOPE/FORM

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Tc-99m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Liquid</td>
</tr>
<tr>
<td>Activity</td>
<td>0.37 GBq (10 mCi)</td>
</tr>
</tbody>
</table>

Form (Special vs. Normal):
- Liquid → Normal Form

EXAMPLE 1: ACTIVITY

Based on activity of 10 mCi, ACTIVITY can be classified as LIMITED QUANTITY!

However, need to take into account radiation levels when determining packaging!
EXAMPLE 1: RADIATION LEVELS/PACKAGING/LABEL

Requirement for use of Excepted Packaging for Limited Quantities:
- Dose rate on surface of package must be ≤ 0.5 mrem/hr

<table>
<thead>
<tr>
<th>Dose rate</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.5 mrem/hr</td>
<td></td>
</tr>
</tbody>
</table>

Based on surface radiation level and Limited Quantity, can use EXCEPTED PACKAGING EXCEPTED from LABELING requirement but NOT from markings, etc.

EXAMPLE 1: MARKINGS

EXAMPLE 1: REPORTABLE QUANTITY

Tc-99m RQ = 100 Ci Not RQ!
EXAMPLE 1: OVERVIEW

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Tc-99m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Limited Quantity</td>
</tr>
<tr>
<td>Package</td>
<td>Excepted Packaging (General Package Design)</td>
</tr>
<tr>
<td>Labels</td>
<td>HOME</td>
</tr>
<tr>
<td>Markings</td>
<td>UN2910</td>
</tr>
<tr>
<td>Shipping Papers</td>
<td>Radioactive</td>
</tr>
</tbody>
</table>

EXAMPLE 1: CONTAMINATION LIMITS

- Area wiped = 300 cm²
- Assess wipes using NaI scintillation detector with an efficiency of 20% with NET result of 800 cpm
- Wipe efficiency of 10%
- Limit for Tc-99m = 240 dpm/cm²

\[
dpm = \frac{800 \text{ cpm} \times 300 \text{ cm}^2 \times 0.2 \text{ cpm/dpm} \times 0.1}{0.1}\]

\[= 133 \text{ dpm/cm}^2\]

EXAMPLE 1: PACKAGE
EXAMPLE 2: ISOTOPE/FORM

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Pu-239</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Solid, oxide (no certifications)</td>
</tr>
<tr>
<td>Activity</td>
<td>0.0224 Ci (22.4 mCi)</td>
</tr>
</tbody>
</table>

Is it Special or Normal Form?

Form:
- If unknown (or unsure if certified as Special Form)

NORMAL form

EXAMPLE 2: ACTIVITY

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Pu-239</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Solid, oxide (normal)</td>
</tr>
<tr>
<td>Activity</td>
<td>0.0224 Ci (22.4 mCi)</td>
</tr>
</tbody>
</table>

Which "A" limit should be used?
What is the Quantity classification?
[LQ = 10^-3 A quantity]
**EXAMPLE 2: ACTIVITY**

<table>
<thead>
<tr>
<th>Symbol of radionuclide</th>
<th>Element and atomic number</th>
<th>A2 (Ci)</th>
<th>A2 (mCi)</th>
<th>A2 (µCi)</th>
<th>Specific activity (mCi/µCi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-239</td>
<td>94</td>
<td>3.8 x 10^-2</td>
<td>2.7 x 10^-2</td>
<td>0.2 x 10^-2</td>
<td>3.7 x 10^-2</td>
</tr>
<tr>
<td>Pu-238</td>
<td>94</td>
<td>3.0 x 10^-2</td>
<td>2.1 x 10^-2</td>
<td>0.1 x 10^-2</td>
<td>2.9 x 10^-2</td>
</tr>
<tr>
<td>Pu-240</td>
<td>94</td>
<td>3.3 x 10^-2</td>
<td>2.3 x 10^-2</td>
<td>0.2 x 10^-2</td>
<td>3.3 x 10^-2</td>
</tr>
</tbody>
</table>

Based on the activities of 0.0224 Ci Pu-238, cannot be classified as LIMITED QUANTITY!

However, since \( A_2 \) is considered a TYPE A quantity.

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**EXAMPLE 2: RADIATION LEVELS/PACKAGING/LABEL**

<table>
<thead>
<tr>
<th>Dose rate</th>
<th>Pu-238 (Type A quantity)</th>
<th>Product</th>
<th>Surface</th>
<th>TRANSPORT INDEX</th>
<th>Maximum radiation level at any point on external surface</th>
<th>Labeled category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>≤ 0.5 mrem/hr</td>
<td>NONE</td>
<td>≤ 0.5 mrem/hr</td>
<td>0</td>
<td>NONE – Limited Quantity</td>
<td>WHITE-I</td>
</tr>
<tr>
<td>0</td>
<td>≤ 0.5 mrem/hr</td>
<td>WHITE-I</td>
<td>≤ 0.5 mrem/hr</td>
<td>0</td>
<td>NONE – Limited Quantity</td>
<td>WHITE-I</td>
</tr>
<tr>
<td>&gt; 0 and &lt; 1</td>
<td>&gt; 0.5 mrem/hr and ≤ 3.0 mrem/hr</td>
<td>YELLOW-I</td>
<td>&gt; 0.5 mrem/hr and ≤ 3.0 mrem/hr</td>
<td>&gt; 0 and &lt; 1</td>
<td>&gt; 0.5 mrem/hr and ≤ 3.0 mrem/hr</td>
<td>YELLOW-I</td>
</tr>
<tr>
<td>&gt; 1 and &lt; 10</td>
<td>&gt; 3.0 mrem/hr and ≤ 30 mrem/hr</td>
<td>YELLOW-II</td>
<td>&gt; 3.0 mrem/hr and ≤ 30 mrem/hr</td>
<td>&gt; 1 and &lt; 10</td>
<td>&gt; 3.0 mrem/hr and ≤ 30 mrem/hr</td>
<td>YELLOW-II</td>
</tr>
<tr>
<td>&gt; 10 (and includes HRCQ)</td>
<td>&gt; 30 mrem/hr and ≤ 300 mrem/hr</td>
<td>YELLOW-III</td>
<td>&gt; 30 mrem/hr and ≤ 300 mrem/hr</td>
<td>&gt; 10 (and includes HRCQ)</td>
<td>&gt; 30 mrem/hr and ≤ 300 mrem/hr</td>
<td>YELLOW-III</td>
</tr>
</tbody>
</table>

What packaging is required? What label(s) are required?

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**EXAMPLE 2: RADIATION LEVELS/PACKAGING/LABEL**

Based on surface dose rate, package can be labeled as WHITE-I and must be a TYPE A package (\( T_I < 0.05 \) and is considered to be 0).

Not intended for use in or incident to medical diagnosis, treatment, research – CARGO AIRCRAFT ONLY.
### EXAMPLE 2: MARKINGS

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Form</th>
<th>Activity</th>
<th>Markings</th>
</tr>
</thead>
</table>
| Pu-238  | Solid, oxide | 0.0224 Ci | Markings

Is it a Reportable Quantity?
EXAMPLE 2: REPORTABLE QUANTITY

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Pu-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Solid, oxide</td>
</tr>
<tr>
<td>Activity</td>
<td>0.0224 Ci</td>
</tr>
</tbody>
</table>

Pu-238: RQ = 0.01 Ci

EXAMPLE 2: OVERVIEW

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Pu-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Type A</td>
</tr>
<tr>
<td>Package</td>
<td>Type A</td>
</tr>
<tr>
<td>Labels</td>
<td>White I</td>
</tr>
<tr>
<td>Markings</td>
<td>Cargo Aircraft Only</td>
</tr>
<tr>
<td>Shipping Papers</td>
<td>Type A Package</td>
</tr>
</tbody>
</table>

EXAMPLE 2: SHIPPING PAPERS

- Passenger vs. cargo aircraft:
  - Not intended for use in, or incident to research, medical diagnosis or treatment
- Dimensions of package
- Activities must be in SI units
- No Ti (White I)
EXAMPLE 2: CONTAMINATION LIMITS

- Area wiped = 300 cm²
- Assess wipes using LSC with an efficiency of 20% with NET result of 20 cpm
- Wipe efficiency of 10%
- Limit for Pu-238 = 24 dpm/cm²

\[
\text{dpm} = \left( \frac{20 \text{ cpm}}{300 \text{ cm}^2 \times 0.2 \text{ cpm/dpm} \times 0.1} \right) = 3.3 \text{ dpm/cm}^2
\]

EXAMPLE 2: PACKAGE

Is it Special or Normal Form?

EXAMPLE 3: ISOTOPE/FORM

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Ge-68</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Solid polymer (no certifications)</td>
</tr>
<tr>
<td>Activity</td>
<td>174 MBq (4.7 mCi)</td>
</tr>
</tbody>
</table>

Is it Special or Normal Form?
**EXAMPLE 3: ISOPOTE/FORM**

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Ge-68</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Solid polymer</td>
</tr>
<tr>
<td>Activity</td>
<td>1.74 MBq (4.7 mCi)</td>
</tr>
</tbody>
</table>

**Form:**
Probably Special Form, but I don’t know for sure!
If unknown or unsure if certified as Special Form

NORMAL form

---

**EXAMPLE 3: ACTIVITY**

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Ge-68</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Solid polymer (normal)</td>
</tr>
<tr>
<td>Activity</td>
<td>1.74 MBq (4.7 mCi)</td>
</tr>
</tbody>
</table>

**Which “A” limit should be used?**
**What is the Quantity classification?**
(LQ = 10^-3 A quantity)

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Ge-68</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Solid polymer (normal)</td>
</tr>
<tr>
<td>Activity</td>
<td>1.74 MBq (4.7 mCi)</td>
</tr>
</tbody>
</table>

**Appropriate A2**

- Appropriate A2 = 1.4E01 Ci (14 Ci)
- Limited = 10^-3 A2 = 14 mCi

Based on activity of 4.7 mCi, quantity can be classified as
LIMITED QUANTITY!

BUT remember the importance of radiation levels…

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EXAMPLE 3: RADIATION LEVELS/PACKAGING/LABEL

<table>
<thead>
<tr>
<th>Transport Index</th>
<th>Maximum radiation level at any position on external surface</th>
<th>Label category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>≤ 0.5 mrem/hr</td>
<td>NONE – Limited Quantity</td>
</tr>
<tr>
<td>0 ≤ 0.5 mrem/hr</td>
<td>WHITE I</td>
<td></td>
</tr>
<tr>
<td>&gt; 0 and ≤ 1</td>
<td>&gt; 0.5 mrem/hr and ≤ 50 mrem/hr</td>
<td>YELLOW II</td>
</tr>
<tr>
<td>&gt; 1 and ≤ 10</td>
<td>&gt; 50 mrem/hr and ≤ 200 mrem/hr</td>
<td>YELLOW III</td>
</tr>
<tr>
<td>&gt; 10 (and includes HRC)</td>
<td>&gt; 200 mrem/hr and ≤ 1,000 mrem/hr</td>
<td>Exclusive Use</td>
</tr>
</tbody>
</table>

What packaging is required? What label is required?

Based on dose rates, must use a TYPE A package that is labeled as YELLOW II.
(White I, Yellow II, Yellow III labels cannot be used on EXCEPTED packaging).

EXAMPLE 3: MARKINGS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description of markings or descriptive phrase used</th>
<th>Regulatory body</th>
<th>Marking</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1226</td>
<td>Example: Dose rate: Instrument or equipment, used to measure dose rate in mrem/hr</td>
<td>U.S. NRC</td>
<td>1226</td>
<td>1226</td>
</tr>
<tr>
<td>1227</td>
<td>Example: Dose rate: Device or equipment, used to measure dose rate in mrem/hr</td>
<td>U.S. NRC</td>
<td>1227</td>
<td>1227</td>
</tr>
<tr>
<td>1228</td>
<td>Example: Dose rate: Apparatus or equipment, used to measure dose rate in mrem/hr</td>
<td>U.S. NRC</td>
<td>1228</td>
<td>1228</td>
</tr>
<tr>
<td>1229</td>
<td>Example: Dose rate: Machine or equipment, used to measure dose rate in mrem/hr</td>
<td>U.S. NRC</td>
<td>1229</td>
<td>1229</td>
</tr>
<tr>
<td>1230</td>
<td>Example: Dose rate: Apparatus or equipment, used to measure dose rate in mrem/hr</td>
<td>U.S. NRC</td>
<td>1230</td>
<td>1230</td>
</tr>
<tr>
<td>1231</td>
<td>Example: Dose rate: Device or equipment, used to measure dose rate in mrem/hr</td>
<td>U.S. NRC</td>
<td>1231</td>
<td>1231</td>
</tr>
</tbody>
</table>
EXAMPLE 3: MARKINGS

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Form</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ge-68</td>
<td>Solid polymer</td>
<td>174 MBq (4.7 mCi)</td>
</tr>
</tbody>
</table>

Is it a Reportable Quantity?

Ge-68: RQ = 10 Ci

NOT RQ!
EXAMPLE 3: OVERVIEW

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Limited Quantity</td>
</tr>
<tr>
<td>Package</td>
<td>Type A (because of radiation levels)</td>
</tr>
<tr>
<td>Label</td>
<td>Yellow II</td>
</tr>
<tr>
<td>Markings</td>
<td>UN2915 Type A package</td>
</tr>
<tr>
<td>Shipping Papers</td>
<td>Required</td>
</tr>
</tbody>
</table>

EXAMPLE 3: SHIPPING PAPERS

- Passenger vs. cargo aircraft:
  - Intended for use in, or incident to research, medical diagnosis or treatment
- Dimensions of package
- Activities must be in SI units
- TI required (Yellow II)

EXAMPLE 3: CONTAMINATION LIMITS

- Area wiped = 300 cm²
- Assess wipes using pancake GM with an efficiency of 25% with NET result of 150 cpm
- Wipe efficiency of 10%
- Limit for Ge-68 = 240 dpm/cm²

\[
\text{dpm} = \frac{150 \text{ cpm}}{300 \text{ cm}^2 \times 0.25 \text{ cpm/dpm} \times 0.1} = 20 \text{ dpm/cm}^2
\]
EXAMPLE 3: PACKAGE

EXAMPLE 4: ISOTOPE/FORM

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Sr-90 (HDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Sealed source (Certification)</td>
</tr>
<tr>
<td>Activity</td>
<td>370 GBq (10 Ci)</td>
</tr>
</tbody>
</table>

Is it Special or Normal Form??

EXAMPLE 4: ISOTOPE/FORM

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Sr-90 (HDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Sealed source (Certification)</td>
</tr>
<tr>
<td>Activity</td>
<td>370 GBq (10 Ci)</td>
</tr>
</tbody>
</table>

Certification is provided = Special Form
**EXAMPLE 4: ACTIVITY**

<table>
<thead>
<tr>
<th>A&lt;sub&gt;1&lt;/sub&gt; (special form)</th>
<th>A&lt;sub&gt;2&lt;/sub&gt; (general use)</th>
<th>A&lt;sub&gt;3&lt;/sub&gt; (transport)</th>
<th>A&lt;sub&gt;4&lt;/sub&gt; (storage)</th>
<th>A&lt;sub&gt;5&lt;/sub&gt; (activity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mCi</td>
<td>100 mCi</td>
<td>1000 mCi</td>
<td>10000 mCi</td>
<td>100000 mCi</td>
</tr>
</tbody>
</table>

The activity of 10 Ci is a special form, as determined from a measurement of the rate of decay or a measurement of the radiation level at specified distances from the source.

**EXAMPLE 4: ACTIVITY**

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Form</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ir-192</td>
<td>Sealed source (Certification)</td>
<td>370 GBq (10 Ci)</td>
</tr>
</tbody>
</table>

**EXAMPLE 4: RADIATION LEVELS/PACKAGING/LABEL**

<table>
<thead>
<tr>
<th>Transport Index</th>
<th>Maximum radiation level at any point on exterior surface</th>
<th>Label category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>≤ 0.5 mrem/hr</td>
<td>NONE – Limited Quantity</td>
</tr>
<tr>
<td>0</td>
<td>≤ 0.5 mrem/hr</td>
<td>WHITE-I</td>
</tr>
<tr>
<td>&gt; 0 and ≤ 1</td>
<td>&gt; 0.5 mrem/hr and ≤ 30 mrem/hr</td>
<td>YELLOW-I</td>
</tr>
<tr>
<td>&gt; 1 and ≤ 10</td>
<td>&gt; 30 mrem/hr and ≤ 300 mrem/hr</td>
<td>YELLOW-II</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>&gt; 300 mrem/hr and ≤ 1000 mrem/hr</td>
<td>YELLOW-III</td>
</tr>
<tr>
<td>(and includes HRCQ)</td>
<td></td>
<td>Exclusive Use</td>
</tr>
</tbody>
</table>

**EXAMPLE 4: RADIATION LEVELS/PACKAGING/LABEL**

Based on activity of 10 Ci, quantity classification is Type A.
EXAMPLE 4: RADIATION LEVELS/PACKAGING/LABEL

<table>
<thead>
<tr>
<th>Transport Index</th>
<th>Maximum radiation level at any position on external surface</th>
<th>Label Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>≤ 0.5 mrem/hr</td>
<td>NONE – Limited Quantity</td>
</tr>
<tr>
<td>0</td>
<td>0.5 mrem/hr</td>
<td>WHITE I</td>
</tr>
<tr>
<td>0–1 and &lt; 1</td>
<td>&gt; 0.5 mrem/hr and ≤ 30 mrem/hr</td>
<td>YELLOW II</td>
</tr>
<tr>
<td>&gt; 1 and &lt; 10</td>
<td>&gt; 30 mrem/hr and ≤ 200 mrem/hr</td>
<td>YELLOW III</td>
</tr>
<tr>
<td>≥ 10 (and inclusive)</td>
<td>&gt; 200 mrem/hr and ≤ 1,000 mrem/hr</td>
<td>Exclusive Use</td>
</tr>
</tbody>
</table>

Based on dose rates, package must be labeled as YELLOW III and must use TYPE A packaging. Cargo Aircraft Only (TI > 3).

EXAMPLE 4: MARKINGS

<table>
<thead>
<tr>
<th>Marking</th>
<th>Hypothetical material description or product name</th>
<th>Identification number</th>
<th>Marking number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARKING</td>
<td>hypothetical material description or product name</td>
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<td>Marking number</td>
<td>Description</td>
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<td>Description</td>
</tr>
</tbody>
</table>

Based on dose rates, package must be labeled as YELLOW III and must use TYPE A packaging. Cargo Aircraft Only (TI > 3).
EXAMPLE 4: REPORTABLE QUANTITY

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Isotope (HDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Sealed source</td>
</tr>
<tr>
<td>Activity</td>
<td>370 GBq (10 Ci)</td>
</tr>
</tbody>
</table>

**Is it a Reportable Quantity?**

Ir-192 RQ = 10 Ci

EXAMPLE 4: MARKINGS

- UN 3332
- RQ
- Weight (due to shielding > 110 lb)

HEAVY PARCEL
APPROXIMATE WEIGHT KG

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EXAMPLE 4: OVERVIEW

<table>
<thead>
<tr>
<th>Feature</th>
<th>Type A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Type A</td>
</tr>
<tr>
<td>Package</td>
<td>Type A</td>
</tr>
<tr>
<td>Labels</td>
<td>Yellow III</td>
</tr>
<tr>
<td>Markings</td>
<td>UN3332 KG, HA97 with waiver, Type A package, Required, Emergency Response Information</td>
</tr>
</tbody>
</table>

EXAMPLE 4: SHIPPING PAPERS

- Passenger vs. cargo aircraft:
  - Intended for use in, or incident to research, medical diagnosis or treatment
  - HOWEVER: must be transported via cargo aircraft (TI > 3)
- Dimensions of package
- Activities must be in SI units
- TI required (Yellow III)

EXAMPLE 4: CONTAMINATION LIMITS

- Area wiped = 300 cm²
- Assess wipes using pancake GM with an efficiency of 15% with NET result of 200 cpm
- Wipe efficiency of 10%
- Limit for Ir-192 = 240 dpm/cm²

\[ dpm = \frac{200 \text{ cpm}}{300 \text{ cm}² \times 0.15 \text{ cpm/dpm} \times 0.1} = 44.4 \text{ dpm/cm}² \]
EXAMPLE 4: PACKAGE

CONCLUSION

LEARNING OBJECTIVES

1. Review NRC and DOT regulations applicable to the following:
   - Training and certification of personnel who package/transport radioactive material
   - Classification of radioactive material
   - Special vs. Normal form
   - Quantities
   - Packaging of radioactive material
   - Labeling and marking of radioactive material packages
   - Transportation of radioactive material
   - Radiation level limits and contamination control
   - Receipt and opening of radioactive material packages
“WORDS OF WISDOM”

- FedEx is a common way to ship radioactive material packages (Excepted, Type A)
- Follow IATA
- Dangerous Goods Hotline for FedEx
  - Packages may be returned for “no reason”
  - Call and ask
- Only need two copies of Dangerous Goods Declaration with red border (the rest can be copies)
- Keep up with the regulations

AND MORE...

- If you have your own transportation program, consider various methods
  - e.g., LSA, SCO, LQ
  - Check the regs!!!
- Look for loopholes for packaging, surveys, physician exemptions, etc.

FINALLY...

- Keep packages for items received (e.g., sealed sources)
  - If they will be returned
  - If returning source to vendor, they usually have packaging (Type A) available for purchase
  - Double-check EVERYTHING!
- Make sure the emergency phone will be answered during the entire shipping period
- If you need to ship overseas, hire a shipper
- Fill-in Dangerous Goods Declaration forms available online [use one with columns!]
- Set up a training program and keep records
- Consult!
REFERENCES

- Code of Federal Regulations
  - Title 10
  - Title 49
  - Title 71
- “Regulations for the Safe Transport of Radioactive Material” 2018 Edition; IAEA Specific Safety Requirements No. SSR-6 (Rev. 1)
- “Transportation of Radioactive Material” Reactor Concepts Manual, USNRC Training Center, Rev 0703
- www.ecfr.gov
- www.phmsa.dot.gov
- Resources, regulatory updates, training
- Dangerous goods hotline – 1-800-463-3339
- IATA variations (exceptions to IATA dangerous goods regulations)